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Eastern Pacific Expeditions of the New York Zoological Society. XXVII.

A Study of Young Sailfish (*Istiophorus*).[1]

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Plates I–V; Text-figures 1–9.

[This is the twenty-seventh of a series of papers dealing with the collections of the Eastern Pacific Expeditions of the New York Zoological Society made under the direction of William Beebe. The present paper is concerned with specimens taken on the Eastern Pacific *Zaca* Expedition (1937–1938). For data on localities, dates, etc., refer to *Zoologica*, Vol. XXIII, No. 14, pp. 287-298.]

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Introduction.

When the *Zaca* was drifting one night off the western coast of Mexico, a young Pacific sailfish (*Istiophorus greyi*), only three and one-quarter inches in standard length, came to our submerged light and was caught. This was on November 23, 1937. Nine weeks later and twelve hundred miles to the southeast, off Costa Rica, a second specimen, one and five-eighths inches long, was taken under similar circumstances. For comparison with these I have a thorough description of a newly caught adult fish, nine feet, eight inches in length, taken by us off Costa Rica, together with its skull and part of its skeleton. For all these Pacific sailfish I have to thank Mr. Templeton Crocker, for it was under his aegis and on his yacht that the Thirty-eighth Expedition of the Department of Tropical Research of the Zoological Society was made.

For additional study, Mr. Duncan Holmes has kindly sent me a Florida specimen of the Atlantic sailfish (*Istiophorus americanus*) two and three-quarters inches long, and the American Museum of Natural History has loaned me a skull and nearly complete skeleton of an adult also taken in Florida waters.

With such meagre material, the direct recording of descriptive facts is all that can be done with any assurance of ultimate value. No attempt has been made at this time to unravel the systematic tangle of the so-called species of *Istiophorus*. Some of the forms have been based on mounted specimens and even photographs, or on a single individual. For purposes of convenience, I use the two commonly accepted specific names for the sailfish of our Atlantic and of our Pacific coasts, *americanus* and *greyi* respectively.

The comparative characters I have been able to examine in my few fresh specimens show confusing variations, and relationship with other characters of doubtful value for differentiation. For example, in two adult skulls, one *greyi*, the other *americanus*, the relative lengths of the projecting part of the upper jaw are 50 percent. and 48 percent. respectively, while the supposed diagnostic characteristic of slenderness of the snout is identical in both.

The extreme weights of the adult sailfish from the two oceans seem to be a definite but rather unusable character of differentiation. The heaviest recorded Atlantic fish weighed 120 pounds, while Pacific individuals certainly reach 190, and very probably 220 pounds.

In the year 1831 Cuvier & Valenciennes described and figured a sailfish, calling it *Histiophorus pulchellus*, which they said was *"n'est long que de quatre pouces"* (Text-fig. 1 h). Ten years later Ruppell described and also figured what he called *H. immaculatus* from the Red Sea, measuring eighteen inches or about 457 mm. (Text-fig. 1 i). Günther in 1873–74 published figures of the first really young sailfish, specimens of 9, 14 and 60 mm. (Text-figs. 1 b, c and f). In 1880 Lütken described a series from 5.5 to 21 mm. and figured the smallest (Text-fig. 1 a). The

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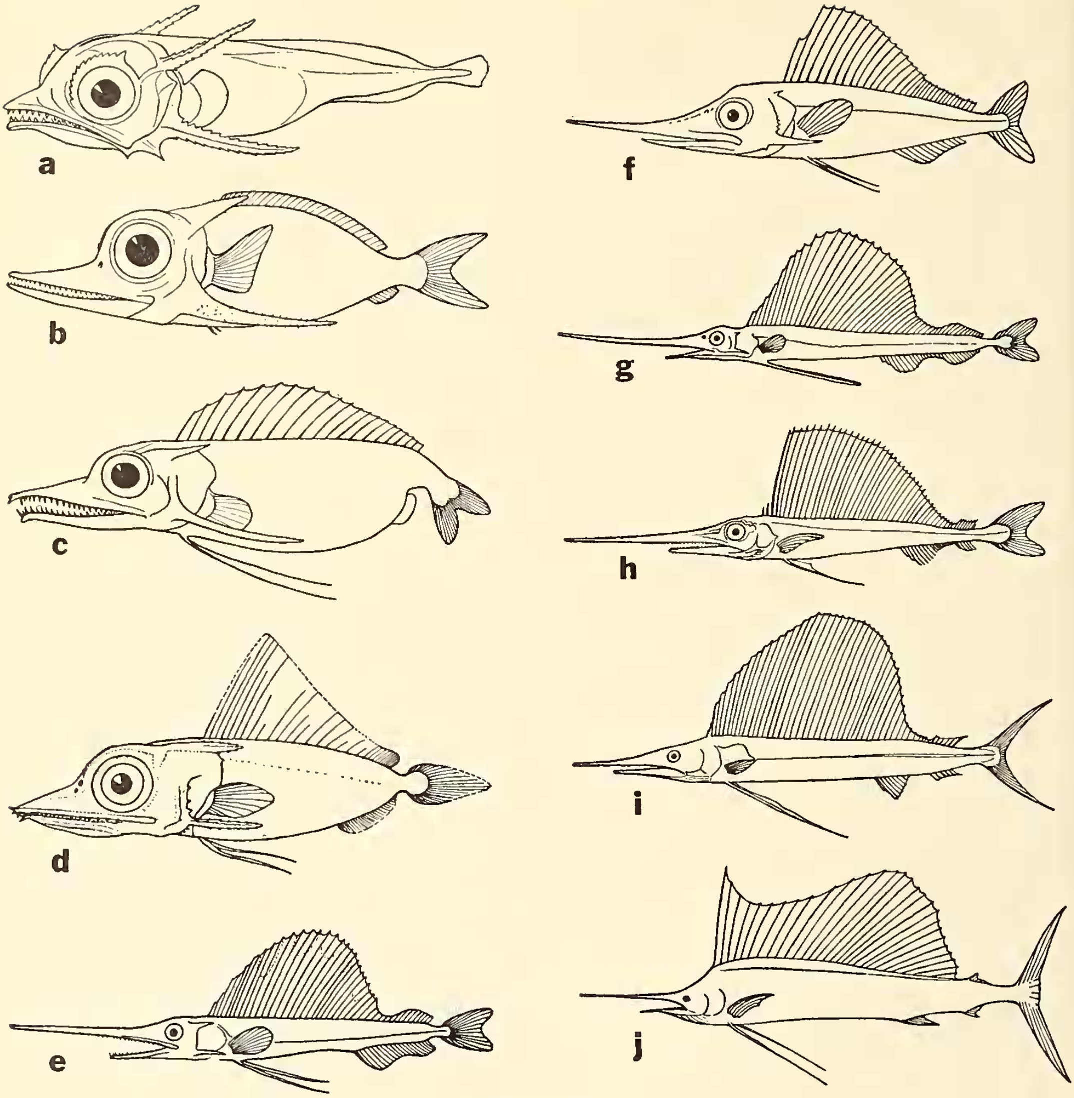


Text-figure 1.

Nine Stages of Growth of *Istiophorus* (see page 225). **a**, 5.5 mm. (Lütken, 1880); **b**, 9 mm. (Günther, 1873–74); **c**, 14 mm. (Günther, 1873–74); **d**, 16.5 mm. (LaMonte & Marcy, 1941); **e**, 42 mm. (Beebe, p. 210); **f**, 60 mm. (Günther, 1873–74); **g**, 84 mm. (Beebe, p. 213); **h**, 108 mm. (Cuvier, 1831); **i**, 457 mm. (Ruppell, 1841); **j**, 2616 mm. (Beebe, p. 221).

descriptions and illustrations of these small fish were exceedingly sketchy, so I have chosen only to present a few dominant features, which may be of ultimate use in clarifying their age and exact identification, when we have sufficient material for comparison. (Page 225.)

While there are doubtless a number of young sailfish in collections, as yet unrecognized, I know of only three which will soon be reported upon. One of 14.3 mm. in the American Museum of Natural History is being described by Miss Francesca LaMonte (Text-fig. 1 d) and two Pacific sailfish "four and three-quarter inches in length," taken during the present year by a Field Museum expedition in Panama Bay.

For the staining and clearing of the two young sailfishes of 70 and 84 mm. I am indebted to Miss Gloria Hollister, and for the text-figures to Mr. Donald Greame-Kelly. The photographs were taken by Miss Jocelyn Crane and Mr. Toshio Asaeda. Measurements are from fresh specimens.

Istiophorus greyi Jordan & Hill.

Pacific Sailfish.

Material Studied: One young specimen, of 42 mm. standard length, taken in hand-net at night light, at surface, over 67 fathoms, at 11:30 P. M. March 1, 1938, from the deck of the *Zaca;* on the Eastern Pacific *Zaca* Expedition of 1937–38, of the Department of Tropical Research, New York Zoological Society; Station 215, L-1; 9° 03′ North Lat., 84° 06′ West Long., 23 miles west of Uvita Point, Costa Rica. Cat. No. 28,426; Col. Pl. Z-201; Photograph 9031.

Field Characters: A small, slender fish, head and snout longer than the rest of the body; eye very large; two prominent cephalic spines, upper jaw projects beyond lower more than the length of the latter; shining steel blue except for white forward belly and lower jaw; tall, circular dorsal fin dusky, with large, black, basal spots and terminal yellow ones; pelvics long, slender, yellow; all other fins, including low, posterior part of dorsal, hyaline. Although one-sixtieth the length of a full-grown fish, this young specimen has all the general aspects of an adult; the enormous dorsal fin, the elongated upper jaw and pelvic fins identify it at a glance. (Plate I, figs. 1, 2.)

Ecology and Habits: There is little enough I can contribute under this heading. This is the smallest Pacific sailfish ever seen or captured. It came to the night light of the *Zaca* as she drifted slowly along on a quiet sea, twenty-three miles off shore, off Uvita Point, Costa Rica, over a depth of about sixty-seven fathoms. Around the light were the usual lot of small fish, scombroids, squirrelfish, demoiselles, puffers, dolfins and brilliantly colored butterflying fish. All were young, and as usual it was always surprising to find such small fry in such deep water, so far out at sea.

The baby sailfish we are studying, one and five-eighths inches in length, was seen as it appeared and vanished several times, but not until it was actually in the net was it recognized. This was about 11:30 P. M. just before we put out the light. When in the water, there was no hint of diagnostic dorsals or pelvics, nor even of beak. In a small aquarium it dashed about with such violence that I feared serious injury to its sail or beak and killed it, my artist getting the exact colors before it expired. Measurements and full color description were also taken. While I watched it darting about, the dorsal was about one-third exposed, but quiescent, and the pelvics were likewise almost hidden. I noticed only quick twists of the posterior body and caudal fin as motive and directional power.

Color: Body shining steel-blue with a small, pale spot on the top of the head, and six, wide, fairly distinct bands down the sides. These vanished soon after death. Upper jaw all steel blue, also sides of head and anterior and upper part of opercles. Eye silvery, bluish-white. Lower jaw dead white, branchiostegals and belly silvery-white. Lower side of body from well in front of anal backward, almost as dark blue as the back. Posterior dorsal, anal and pectorals hyaline; caudal translucent white.

Dorsal in general appearance black with narrow, lemon-yellow streaks extending up the rays and along the distal edge. In detail, we find three, large, jet-black, slightly elongate, but almost round spots along the central three-fifths of the basal area of the fin, their lower contour partly sunk into the dorsal profile of the body. Entire fin elsewhere with black webs and lemon-yellow rays. Near the edge of the fin, the yellow extends on to two adjoining webs, resulting in five, definite yellow spots. Narrow base of posterior pigmented rays clear lemon-yellow.

From the thirty-eighth back, the remaining elements are hyaline. These are at first short, and then the fin expands into a terminal, higher lobe. The webs of the pelvics are bright straw yellow, the brightest color on the fish. The caudal fin shows a scattering of small but definite round, dark spots, adumbrating the two black areas in the larger specimen.

Measurements and Counts: Total length 46.5 mm.; standard length 42; depth at pectoral 4.2; depth at origin of dorsal 4.2; depth at origin of anal 2.8; depth at peduncle 1.3; head 21.7; eyeball 2.8; iris horizontal 2.3; iris vertical 2; snout 15; snout to dorsal 21; snout to pectorals 22; snout to pelvics 22.2; maxillary 18; lower jaw 8; lower jaw-tip to snout-tip 9.5; front eye to rear opercle 6.7; upper pterotic spine 1.7; lower preopercular spine 2.8; dorsal height, first spine .8; dorsal height, fourth spine 4.3; dorsal height fifteenth spine 13.5; first anal lobe base 1.5; lobe height 2.1; second anal lobe base 1; lobe height 1; caudal fin spread 3.3; central caudal rays 4; caudal lobe 4.7; pectoral base 1; pectoral width 1.7; pectoral length first spine 4.3; pectoral length, fifteenth ray .8; pelvic spine 1.5; pelvic elongate ray 11; pelvic short ray 2.3 mm.

Counts: Dorsal $4 + 36 + 6 + 9 = 55$; anal count $3 + 8 + 7 + 8 = 26$; pectoral count $1 + 18 = 19$; pelvic count $1 + 2 = 3$.

Weight: One-half gram.

General Body Form: This young sailfish is elongate and slender, deepest at the posterior edge of the opercle; anteriorly from the crown, the profile slopes rather gently down and in a long curve to the elongated upper jaw, the elongate portion being curved slightly upward. The body is straight, the slight narrowing caudalwards being brought about by a gentle slope down of the dorsal profile. The depth is contained in the standard length exactly ten times. Between the end of the unpaired fins and the origin of the caudal the peduncle is distinctly narrowed, the terminal portion of the body widening again to accommodate the caudal.

Head: The bones in general seem well developed, but the frontals and supraoccipital are so thin that every detail of the brain is visible.

Skin: The body is covered thickly with minute erect spines, becoming more dense on the posterior half of the body so that the separation of the spines is about equal to their height. They are greatly reduced or absent on the head, and the skin near the bases of the unpaired fins and their sheaths are also spineless. Details of the scales are not apparent in the uncleared specimen. As in the adult fish, the dorsal and pelvic fins are furnished with deep subdermal sheaths into which they can be folded and sunk out of sight for stream-lining.

Snout: The snout, even at this early stage, is characteristic, projecting far forward, beyond the lower jaw. It is formed by an extension of the premaxillary, and in this young individual this structure is almost a full third of the length of the fish. The snout is curved gently upward and slightly flattened, the depth and width halfway to the tip, being .62 and .86 mm. respectively. Two deep lateral furrows mark the dorsal surface.

Eye: The eyes are very large, occupying much of the side of the head, breaking the dorsal contour, as well as the line of the upper jaw, behind the posterior extension of the maxillary. The eyeball is not quite round and in the iris this dorso-ventral flattening is still more apparent. The interorbital space is flat, but marked by several furrows.

Nostrils: These are relatively large, being one-fourth the diameter of the eye, and they are close in front of the eyes. They are divided by a broad, vertical band into two openings. The partition flares out and forward, and is continued around the anterior opening, giving it a low, tubular appearance, while the frame of the posterior opening is flush with the side of the head.

Opercles: Large but not strongly ossified at this age. A transparent bony ridge arises in front of the eye, just above the nostril, passes back in an even curve over the eye, and terminates in a long, two-keeled, serrated spine, 1.7 mm. in length. A second, larger spine springs from the lower angle of the preopercular, 2.8 mm. long. This reaches back beyond the origin of the pectoral. Both spines are directed slightly outward at a marked angle from the body plane.

Two small, short, toothed ridges arise from the posterior part of the posttemporal and the upper end of the supracleithrum.

Mouth: If we disregard the specialized extension of the premaxillary into a prolonged snout or sword-shaped beak, the mouth of this young sailfish presents no unusual features. The posterior end of the maxillary is at the vertical of the posterior rim of the iris. The mandible is stout and short, contained in the upper jaw two and one-quarter times. It terminates two eye diameters in front of the eye itself, so that this is the only effective, prehensile part of the mouth.

Teeth: The palatine teeth begin 2.5 mm. in front of the posterior end of the maxillary. They are the same size as those on the maxillary, but in an irregular double row, and placed much closer together. The teeth in the maxillary are widely spaced, extend quite to the tip, and tend to arise in separate clumps. At first these are in twos and threes in linear arrangement. In the distal fourth, however, the groups consist of three to seven teeth, and are irregularly arranged, sometimes reaching almost to the center line of the beak. At the very tip are several larger, isolated teeth, one or two in the central line, barracuda-like. There are two, terminal, hyaline, serrated spines, which flare obliquely outward from the very tip.

The mandibular teeth are in two rows, the outer irregular and small. The inner ones are larger, almost palisade-like, often in a double line. These increase in size and inward curvature toward the tip of the jaw, until the last twenty are relatively large fangs, the tips of those on opposite sides almost touching as the jaw becomes narrowed. At the tip, several fangs are directed obliquely forward, forming a pincer-like arrangement, the upper ones curving downward, and the lower ones upward. The mandibular teeth fit between those of the palatine and maxillary.

Dorsal Fin: The dorsal fin is continuous and consists of 55 elements. When the anterior 38 spines are elevated at right angles to the body, the fin forms an almost perfect half circle. Although the whole fin is connected by webs, it may be divided into four more or less distinct parts. The first four spines are closer together and relatively shorter than the succeeding ones. In the adult these seem to be affected as a unit, although in one of several different ways. The first three may disappear altogether above the skin, or they may lose the connecting webbing. In the present specimen, Number 1 is only just visible (.16 mm. in length). The difference in length between the fourth and fifth elements is more than twice as great as between any preceding or succeeding elements.

The next part includes 36 ray-like spines representing those which remain in the adult and form the typical sail. The succeeding division in turn is not radically marked but can be distinguished, forming a group of six elements which are very short and of equal length. They form the area which in the full-grown fish either disappears altogether, thus resulting in two separate dorsal fins, or anteriorly persists as a few stunted elements. It is the disappearance of this group which reduces the dorsal count in the adult so considerably. The last nine elements are rays, judged by the complex splitting of their tips and the presence of cross nodes. They are small but are very even in length.

Anal: The anal fin, like the dorsal, is continuous at this stage of growth, and contains 26 elements. The future changes are fairly well adumbrated even in the outline of the present fin, two well-marked lobes, anterior and posterior, being connected by a deep curve of short elements. The first three are spines, quite different from the remainder which are obviously rays. The first 11 elements will form the first anal in the adult, while the succeeding 7 will usually disappear, leaving the last 8 for the ultimate second anal. The central third are not only shorter than the others but much more fragile, breaking easily at the ray joints. The posterior third is solid, close together, and already corresponds to that part of the dorsal immediately above it. In the adult sailfish the anal will be reduced from 25 or 28, to 16 or 17.

Caudal: There is no hint of the great flukes of the fullgrown sailfish in the undistinguished tail fin of this baby. The lower lobe is slightly longer than the upper, but the spread is considerably less than this length. The lobes are rounded and very slightly indented in the mid-line.

Pectorals: The pectoral fin is well developed, rather short-based, of 18 or 19 elements, the first of which is a very broad and flat spine. The rays are graduated in a very oblique but straight line along the posterior edge, from the 1st which is 4.3 mm. in length, down to the .8 of a mm. of the 15th ray. The general shape of the fin is triangular, with no hint of the falcate curve of the same organ in the adult fish.

Pelvics: These fins are already almost as specialized in reduction of elements and in elongation of a single ray as they are in the adult. In the living and recently dead individual under consideration, these fins showed an unexpected breadth of webbing, and this was constantly distended, as shown in the colored plate. The condition of these pelvics is so similar to those of the cleared and slightly larger individual next to be described that consideration of all details is better left to that fish. Although the pelvic skin sheath in this young sailfish is both deep and long, it cannot quite accommodate the attenuated tips, which, when all the rest of the fin is reefed and hidden, must lie exposed along the abdomen. These tips almost reach the anal fin, falling short by only about 1 mm.

Istiophorus greyi Jordan & Hill.

Pacific Sailfish.

Material Studied: One young specimen of 84 mm. standard length, taken in hand-net at night light, at surface, over 600 fathoms, at 11:30 P. M. November 23, 1937, from the deck of the *Zaca*, on the Eastern Pacific *Zaca* Expedition of the Department of Tropical Research of the New York Zoological Society. Station 186, L-1; 17° 38′ North Lat., 102° West Long., 23 miles west of Sihuatanejo, Guerrero, Mexico. Cat. No. 27,140; Col. Pl. Z-106; KOH 2331. Photographs 8460 and 8461. (Plate II, figs. 3, 4.)

Field Characters: Similar in general appearance to the slightly smaller, preceding young sailfish, except that the cephalic spines have decreased in size, and the intense blue color has spread over the proximal three-fourths of the dorsal fin, while on the body the blue is restricted to the upper half. The yellow on the dorsal and the pelvics is less intense, and the black spots on the dorsal fin have increased in size and number.

Note: Except for the color and many of the measurements which were made from the fresh specimen, the entire study of this individual is based on its appearance after it had been stained and cleared. The shape and relationship of even the most delicate bones are thus unaffected by dissection or disarticulation.

Ecology: On the night of November 23, 1937, when the *Zaca* was drifting slowly, twenty-three miles off shore from Sihuatanejo, Mexico, the subsurface light was put overboard at 9 P. M. Fish were scarce, and most were snapped up by marauding squids. Several *Cololabis* appeared, and eight very young *Coryphaena* or dolfins with varied patterns, changing as we scooped them aboard. A three inch *Cubiceps*-like fishlet came in and at 11:30 a small, inconspicuous fish, which barely escaped the squids several times before it was caught. It proved to be the first young Pacific sailfish we or anyone else had ever seen. In standard length it measured three and one-quarter inches, or 84 mm.

Color: Head and back rich cobalt blue above, silvery below, including lower jaw and sides of head up to half eye level; upper jaw blue for two-thirds and black on distal third of its length; six or seven broad light bands down the side of the body; webs of anterior dorsal elements dusky yellow, unmarked; all of the central part of the fin pale blue, becoming lemon yellow toward tips; much of the dorsal is covered with very large black spots, four of which, oval in shape, touch the back; an oblong spot is attached to the upper part of the second lower spot; six large, slightly elongated spots extend along the margin of the fin, separated by the lemon yellow areas, the two posterior rather close together; pelvic fins pale yellow; pectorals, posterior portion of dorsal and anal, and caudal transparent; the pectoral has a large dusky spot near the anterior base, and the caudal has a roundish dark spot in the center of each lobe.

Food: Dr. Wilson reports that there were six copepods in the stomach, one *Corycaeus*, one *Oncaea* and four *Farranula gibbula*. In addition to these was a small larval fish.

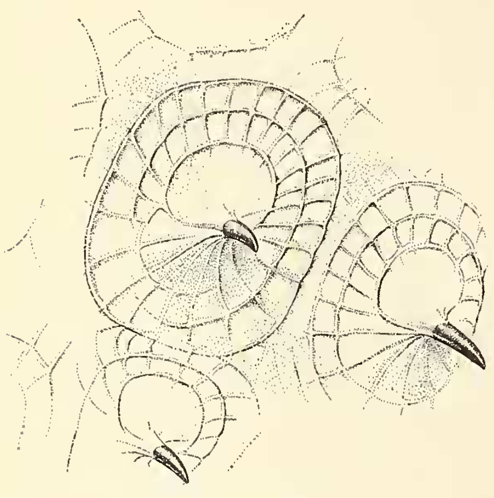
Measurements: Total length 91 mm.; standard length 84; depth at pectoral 6.4; depth at origin of dorsal 6.8; depth at origin of anal 5; depth at peduncle 1.7; head 45; eyeball 4; snout 34.6; snout to dorsal 43.4; snout to pectorals 45.4; snout to pelvics 46; maxillary 38.6; lower jaw 14; lower jaw-tip to snout-tip 25.4; upper pterotic spine 1.4; lower preopercular spine 2.5; dorsal height, second spine .4; dorsal height, fifth spine 5.3; dorsal height, fifteenth spine 27.8; first anal lobe base 2.4; lobe height 3.4; second anal lobe base 2.4; lobe height 1.7; caudal fin spread 10.7; caudal lobe 8.3; caudal middle ray 6.5; pectoral base 1.4; pectoral width 2.5; pectoral length, first spine 6.4; pectoral length, fifteenth ray .3; pelvic spine 2.2; pelvic elongate ray 20; pelvic short ray 2.8 mm.

Counts: Dorsal count (1)4 + 37 + 6 + 8 = 56; anal count 3 + 6 + 8 + 8 = 25; caudal count 12 + 8 + 7 + 12 = 39; pectoral count 1 + 18 = 19; pelvic count 1 + 2 = 3.

General Body Form: This is much as in the 42 mm. specimen, but is even more slender, as the depth is contained somewhat more than twelve times in the standard length.

Skin: Staining and clearing reveal unsuspected scalation of remarkable complexity. Scales are found over the entire body and even a short distance out on the caudal rays. They extend forward on the mid-dorsal line in front of the dorsal fin as far as the vertical of the occiput. Elsewhere on the head they are to be found only in front of the preopercle, a space which they cover completely, and on the area over the posttemporal, from which a very few scattered scales extend down on to the upper part of the opercle. The scales become smaller on the posterior half of the body. The largest observed are near the preopercle, and measure .3 mm. in diameter. (Plate III, fig. 5.)

The density of the scales on the body is such that the edges of the scales touch one another. They may be round, oval, ovate, or almost diamond-shaped, or with slight variations of these outlines, fashioned to fill up most of the interstices between adjoining scales. On the edges of the scaled areas, where there is a slight openness of distribution, the individual scales are usually oval. This separation is especially marked on the posterior half of the peduncle and the remainder of the area affording support for the caudal fin. Here the isolated scales are separated by almost their diameter. (Text-fig. 2).



Text-figure 2.

Scales of 84 mm. *Istiophorus greyi*. × 123.

A typical scale consists of two outer rings coarsely marked with wide-spaced radiating lines. Inside the second ring is a small clear area, and from the posterior rim of this (posterior to the main axis of the fish) arises a long, slender, sharp spine. Posterior to the spine the rings usually break down, and the radiating lines are continued unbrokenly across the whole area and often project beyond the rim as external spines. Other much more minute spine-like projections may be seen at other external segments of the scale, which seem occasionally to anastomose with corresponding projections from adjoining scales. The average scale measures .2 mm. in diameter. Every scale has one of these spines, straight or slightly curved. The only exceptions are the scales immediately behind the pectoral fins, which are altogether smooth. This is the area against which the pectorals are applied when pressed close to the body.

Intermuscular Bones: These are visible as elongate needles of pre-bone. They appear in two rows, one sloping obliquely down and back under the scales in the upper fourth of the sides, and the other slanting back and up in the area above the lateral line.

Lateral Line: A mucous canal, marked by a very narrow but continuous bare line between the scales, passes along the upper branch of the posttemporal, over the tip of the supracleithrum, and curves gently upward to the vertical of the 14th dorsal ray. At this point it bends obliquely down and back to the vertical of the 17th ray and on the mid-line of the body. Here the shape changes into a lateral line effect of numerous, diamond-shaped openings between the scales, separated by hour-glass strands of tissue of varying degrees of thickness. There are about 174 of these pores, ending on the peduncle where the succession is lost in the general separation of the individual scales.

Cephalic Ridge and Spines: A bony, finely serrated ridge arises directly above the nostril, curves backward over the eye, and ends in a strong, sharp spine arising from the tip of the pterotic, 1.4 mm. long, with dorsal and ventral edges strongly serrated. At the lower, posterior angle of the preopercular is a larger spine, 2.5 mm. long, also serrated, with the tip slightly outcurved. There are several small, additional spines below the base of this larger one, and two more above it, along the posterior edge of the preopercle. Both of these cephalic spines are relatively and actually smaller than in the 42 mm. specimen. The posttemporal ridge is reduced to three small teeth.

Dorsal Fin: This relatively enormous fin is continuous in this young sailfish, and in the stained and cleared state is seen to possess 56 elements. The first of these is wholly subdermal, and would never be suspected in the uncleared specimen, although it has a perfectly good but minute spine and an equally distinct but unattached base. It is undoubtedly not an incipient element but a relic, in the course of disappearing.

The fin as a whole is separable into four, more or less distinct divisions. Including the anterior subdermal element, the first five have all the characters of real spines, and in addition there is a real spatial demarcation in relative length between the 5th and 6th elements. This is indicated clearly by four measurements:

4th— 2.6 mm.
5th— 5.4 mm.
6th—10.3 mm.
7th—12.4 mm.

The succeeding thirty-seven elements have rayed tips but no nodes, so that their status as spines or rays is equivocal. However, in the adult, the rayed tips disappear, so I shall class them as spines. This is equally true of the succeeding six, but they are set off by abruptly reduced lengths, and represent those which, in the adult fish, will disappear above the skin or remain represented only by stubs. The anterior boundary of these two groups is evident in another comparison of lengths:

41st—5 mm.
42nd—4.8 mm.
43rd—3.1 mm.
44th—2.6 mm.

The future vanishing of these six elements will inaugurate the external appearance of two separate dorsal fins. This is adumbrated in this young specimen by the distinctness of the last eight rays—true rays both in distal branching and the presence of nodes. They are almost twice the length of the preceding and are subequal in length among themselves. In addition their bases are twice as close together as any of the other dorsal fin elements.

The longest element in the dorsal is the fifteenth, which measures 27.8 mm. in length.

Anal Fin: This fin has 25 elements. The anterior three are spines and the succeeding fourteen elements are ray-like spines. Intimately associated with the three anterior spines are the succeeding six elements, all webbed together, all of a relatively common length, and with their bases very close together. A similar segregation is even more pronounced in the posterior eight unquestionable rays, which are two and one-half times as long as those which go before, and in their turn arise close together. This posterior anal group is very similar to and placed directly beneath the posterior eight of the dorsal. Connecting the two incipiently separate anal groups are eight short, widely spaced rays. These, like the corresponding dorsal equivalents, are doomed to subsequent disappearance.

Caudal Fin: There are 39 elements in the entire fin, 20 dorsal, and 19 ventral. Counting from the smallest, most anterior, undivided, dorsal raylet or spine-like element, there are 12 succeeding ones increasing rapidly in length. The 12th, however, is closely associated, in sudden elongation and strength of ossification, with the next eight, although all of these latter are true rays and are divided into terminal branches. It is thus included in the closely knitted group which ultimately will metamorphose into the dorsal half of the powerful tail cresent. The same sequence is repeated in the ventral half of the fin, except that there are only 7 divided rays instead of 8.

The two caudal lobes in this young fish are equal, 8.3 mm. in length, while the central rays are half as long, 4 mm. These latter will become still less important in subsequent development, until they come to measure less than one-fourth of the swimming lobes.

Pectoral Fin: The shape is roughly triangular, with no hint of the falcate, adult form. It is broad and well-developed, with a stout spine and eighteen rays, but it must function more for balancing than play any important part in swift swimming, for it is only about one-twelfth of the body length, instead of a sixth as in the adult fish. It is well ossified, however, with sturdy bases, and shows no such specialization as we find in other structures in the make-up of this young sailfish. The formula is 1 + 18.

Pelvic Fin: This 84 mm. sailfish is far too old to give us a hint of the early, more normally developed fin such as would probably be apparent in a fish one-third of an inch long. Here we have a sharp, strong spine, closely attached to the elongate ray, free only at its tip, and measuring 2.2 mm. The elongated ray is 20 mm. and is provided with a web of surprising width and strength, so that this fin is by no means as useless as its attenuated length would suggest.

On the inside of the fin is a second ray, free, freely movable and webbed, with a strong, bony base of its own.

The fact that this pelvic fin, as well as the dorsal, is so well supplied with a deep, adequate sheath, hints that it is not merely an over-specialized remnant of some past functional value, but is today of considerable use in some way unknown to us. The strong fore and aft development of the pelvic girdle also suggests an importance for muscular attachment inconsistent with a vestigeal structure.

Skull: The relation of depth to length of the skull in the young sailfish is 7.5 times as compared with 6 in the adult and 7 in *Xiphias*. The chain of suborbitals is very distinct, the componants being considerably larger and more united than in those shown by Cuvier in *Xiphias*, but of course far less developed than we find in *Scomber*. They are oblong, but their outer borders are so irregular and they are so diversely connected with each other that an accurate count is impossible. They surround the orbit in somewhat more than a half circle.

General observation of the anterior part of the skull reveals that the sword is dominately premaxillary, with the chief center of ossification not far from where the maxillary cuts in between the two posterior branches of the anterior element. The nasal is sharply delimited below where it parallels the maxillary, and it forms a considerable part of the antero-superior contour of the narial cavity. Anteriorly it is ossified with the superior branch of the premaxillary, but the line of demarcation can easily be made out. The vomer has a strong anterior facet.

The ethmoid complex is scarcely ossified, except for the posterior upright border of the parethmoid. Considering the skull as a whole, the bony supports in the adult concerned with the receiving and absorption of the terrific side-swiping stresses of the sword, are only just beginning to be apparent in this young fish. The engulfing apparatus with its normal rows of regular teeth is for the present a real working mechanism, rather than the anlage of a battering ram or broad-sword.

That portion of the supraoccipital and frontals covering the brain is almost without ossification and is quite transparent. The surface is covered with an infinite number of extremely minute spines or tubercles, visible only under high power. The hyomandibular, metapterygoid, symplectic and quadrate are all distinct and differ little from the corresponding bones in the adult skull.

Opercles: The preopercular is narrow, straight and upright, in shape and position thus resembling the corresponding bone in *Xiphias* rather than that of the adult *Istiophorus.* It is very strongly ossified anteriorly, and especially at the corner which supports the strong spine. The posterior part has almost no ossification at this stage. From the antero-superior facet of the opercle there springs a strongly ossified, radiating fan of body ridges, but the posterior part, overlying part of the pectoral arch, is scarcely defined. Only the upper edges of the three other opercular elements have taken up the bone stain.

Snout: The snout in this young specimen is only two and a half, not three times, contained in the standard body length. The sword has a decided upward curve throughout its length, and the flattening is not as apparent as in the 42 mm. young fish.

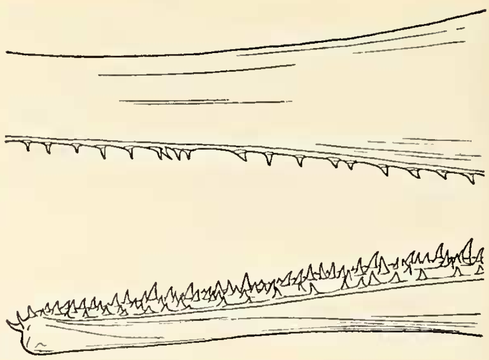
Teeth: The upper jaw is armed with a single row of well-developed wide-spaced teeth, about seventy in the basal 65% of the maxillary. The rest of the tip (10 mm.) is almost edentulous, with the slightest scattering of teeth, minute and quite adventitious as to location and regularity. At the very tip is a group of four or five enlarged teeth, which are directed outward and point in all directions. There are teeth throughout the entire length of the mandible, double rows in places, and much closer together and more numerous than are those of the upper jaw. They number 70 to 80 in a single row along one side. They increase slightly in size distally, until the tip is a mass of close-set fangs, with unusually large ones out-jutting from the extremity.

All these teeth are real, separate dental structures, easily detached, broad bases and all, and with nothing in common with the denticles of the adult fish. (Text-fig. 3.)

Vertebral Column: The vertebral column is fairly well ossified, although bony deposits are less apparent in the centra than in the neural and haemal arches and spines. There are 24 vertebrae, 12 pre-caudal and 12 caudal, and the adult characters in all are so distinctly adumbrated in faint osseous staining that they call for little comment.

The anterior neural zygopophyses of the 1st vertebra are very high and rounded, almost as conspicuous as the neural arch of the 2nd.

The specialized neural arch of the 2nd vertebra is relatively very large in this young individual, rising high above the succeeding arches and spines, appearing as a great up-reaching tongue of



Text-figure 3.

Teeth of 84 mm. *Istiophorus greyi.* × 18.

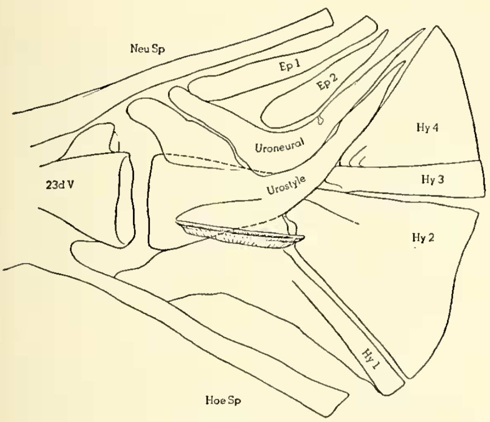
bone lying close alongside the interneural of the 10th dorsal spine.

As we approach the tail there is a marked increase in strength of ossification of the neural and haemal spines and especially of the centra themselves. The 21st vertebrum is the last morphologically unspecialized element of the column, although the 20th shows increased ossification. But from here to and including the 24th or urostyle, the scarlet staining shows a bony deposit equalled in strength only by that in the jaws and teeth. There is no doubt that these structures and localities are of greatest importance to the young fish of this age.

Ribs: The first two ribs arise from the 1st and 2nd postcranial vertebrae. They are identical with each other and quite unlike the succeeding elements. In size and general direction they bear more resemblance to epipleurals than to true ribs, but they arise however, from the centra in true rib fashion. They are about half the diameter of the following ribs, and curve sharply backward. The first ends close beneath the second, and the sharp curve of the latter takes it across the 3rd rib not far below its head. The succeeding ribs are the strongest ossified parts of the anterior axial skeleton. The maximum in size, length and curvature is reached in the 6th and 7th, while the 12th and last pair, situated just before the vertical of the anal opening, is short and almost straight. This pair is actually shorter than the succeeding corresponding elements forming the first haemal arch.

The location of origin of the ribs in relation to the dorsal fin elements is as follows: The 1st rib arises between the 5th and 6th spines; 2nd, 7–8; 3rd, 10–11; 4th, 13–14; 5th, 16–17; 6th, 19–20; 7th, 21–22; 8th, 24–25; 9th, 26–27; 10th, 28–29; 11th, 30–31; 12th, 32–33rd spines.

Caudal Vertebral Complex: In the 21st vertebra the neural and haemal spines are typical, except that they are somewhat narrower than the preceding ones. In the 22nd, specialization is extreme, and the neural spine, which has not yet ossified with the arch, has lengthened until it extends to a vertical of half across the centrum of the urostyle, and underlies the anterior, four caudal raylets. The proximal half is a narrow flat leaf, which changes abruptly into a thin, sharp splinter, identical with the corresponding part of the equally elongated haemal spine. An interesting condition is the unossified base of the haemal process, together with the enlarged character of this element. (Text-fig. 4.)



Text-figure 4.

Caudal complex of 84 mm. *Istiophorus greyi.* × 25.

The 23rd vertebra is very strongly ossified and less hour-glass shaped than the others. It possesses slender but well-developed anterior neural and haemal zygopophyses which perform their usual function. The haemal process is free from the centrum, the dorsal face of the process showing as a thin, wide-spread sheet of bone. The already large size of this structure, and its flaring edges anticipate the ultimate radical spreading of this bone, reaching up over more than half of the entire centrum, increasing its zygopophysial forward extensions, and swinging sharply backward, passing between the anterior haemal zygopophyses of the 24th vertebra, and in the adult, fusing its great blunt-headed spine with the 1st hypural.

Thus we have three distinct developments at this early age, in the neural and haemal spines of the 21st, 22nd, and 23rd vertebrae; in the 21st the spines are large, narrow, flattened leaves; in the 22nd both are reduced, with the distal halves needle-like; in the 23rd they are again enlarged and elongate, subequal throughout and truncate.

The 24th vertebra or urostyle is but little specialized in its anterior half, presenting a perfect half centrum and large, normal neural and haemal zygopophyses. From the side of the base of the haemal process arises a large, thin, fan-shaped, horizontal sheet of bone, the analage of the lateral caudal process in the full-grown sailfish. It measures .7 mm. from front to back, equal to the length of the half centrum of the ultimate vertebra.

From the posterior end of this last centrum, the urostyle proper curves steeply upward as an ossified finger, its attenuated tip almost reaching the upper angle of the 3rd hypural, the upper element of the caudal fan.

The 24th vertebra sends strong, anterior haemal zygopophyses forward, enclosing the haemal spine of the 23rd. Each of these zygopophyses has a strongly ossified wing, below the haemal arch and between the zygopophysis and the 1st hypural. The latter is a strong, broad bone, rather wider at the tip than at its origin. It is quite free from the 2nd hypural, or lower caudal fan bone. The upper half of the caudal fan is separated almost to the base, from the lower half. A faint hint is observable of what in the 70 mm. fish is a distinct seam across the upper half of the hypural trail fan.

The 24th vertebra shows a rather small, specialized neural process with an anteriorly directed wing. Directly above it is a long, anterior branch of a free uroneural, which broadens out posteriorly and sends another arm up, parallel to and dorsal to the urostyle. This, in the adult *Xiphias* and *Istiophorus*, is called a hypural by Gregory and Conrad. It is, however, a paired bone and also superior to the urostyle, and hence is a typical uroneural. Above this bone are two free epurals. They extend full out to the contour of the caudal complex, and are stout and truncated. Their anterior ends fit into the area between the wide-spread arms and the body of the uroneural.

The next and last superior element in the caudal supporting complex is the broad, truncate, hypural-like, prolonged neural spine from the 23rd vertebra.

Dorsal Fin Bases: The first dorsal element is altogether subdermal, although it has a minute spine and a very small base, which is quite unattached. The spine of number two penetrates the skin, but only for the distance of .32 of a mm. It also has a very small and unattached base. The 3rd spine is 3 mm. long. It sends down a slender interneural which lies close in front of the succeeding interneural, but by far the major part of its subdermal process is a large, wide-spread bony fan which extends forward in the midline, a distance of 1.5 mm. over the exoccipitals and on well over the vertical of the supraoccipital.

From here on, posteriorly, the subdermal part of the dorsal fin shows little variation, the spines splaying out beneath the skin into a pair of flat, strong bony expanses, affording ample attachment to the interneural elements. These latter are transversely broad at the top, changing into a flattened, fore and aft blade at the lower end. In this young fish there are two separate elements in the interneural complex. One is short and cone-shaped, lying chiefly between the bases of the spines. It articulates loosely with the posterior base and extends almost straight forward, beneath the next element, notched on the way for articulation with the short posterior spine of the latter. It finally articulates, end on, with the upper head of the interneural. These interneurals are almost vertical in the anterior dorsal elements, and the inter-basal bone is hardly apparent, although there is as yet no hint of the crowding together and actual ossification of these anterior interneurals in the adult fish. Posteriorly, the interneurals become shorter and more oblique until they are almost horizontal and no longer than the superior, inter-basal bone.

The posterior eight rays of the dorsal have their bases twice as close together as the preceding ones, and all but the last have a great bony sheet or thin, wing-like structure developed down and back from the oblique interneurals, reaching to and parallel with the upper line of the great leaf-like neural spines of the 18th and 19th vertebrae. The last ray, which is completely double, springs from a single base and has only a very small, horizontal subdermal bone as its base.

Anal Fin Bases: Subdermally, and judging by the interrelationship of the interhaemals, it is only the first 6 elements, 3 spines and 3 rays, which form a cohesive unit, and not 9, as we would assume from external observation. The 1st interhaemal is very large, triangular, with the broad base stretching forward along the body contour, almost to the anus, a distance nearly equal to the length of its spine. The succeeding interhaemals are all much alike, flattened, truncate, strongly ossified.

The anterior six slant slightly forward, but from the 7th back this angle is greatly increased, until up to the 17th, these bones are not far from the horizontal. From the 18th on, the bases, like those of the incipient 2nd dorsal, develop a great, thin wing which almost unites the group into one solid sheet. The exception is the last, double element, which has only a small, independent base. To avoid confusion with published counts of median fin elements of *Istiophorus*, I am considering the last double ray as one; but elsewhere in conformity with its evolutionary significance, I always recognize this double element as two rays.

Pectoral Girdle: The superior elements are not greatly unlike those of the adult. The posttemporal is distinctly three-pronged, more pronouncedly so than in the full-grown fish. The dorsal and ventral branches are much wider apart, giving the general external aspect of a turkey wishbone. The uppermost branch, connecting with the epiotic is narrow, rounded at the tip, and flattened horizontally. The median is long and slender, and connected with the fork by a wide, thin wing. Posteriorly there is a rounded, conspicuous angle into which the anterior head of the supracleithrum will fit, but which in the present stage of ossification appears quite isolated. Text-figs. 5 & 6).

The supracleithrum is a well-developed, blade-like bone, articulating with the flattened base of the posttemporal. It extends down and slightly back from the vertical and overlies the superior prong and the posterior flaring wing of the cleithrum. The two external toothed ridges, so conspicuous on the head of the 42 mm. sailfish, are still seen projecting above the skin. One is ossified with the upper, posterior edge of the head of the supracleithrum, and the other to the external basal neck of the posttemporal. In the adult bones, vestigeal remains of both ridges can still be detected, especially in the series of teeth on the upper posterior knife-edge of the supracleithrum.

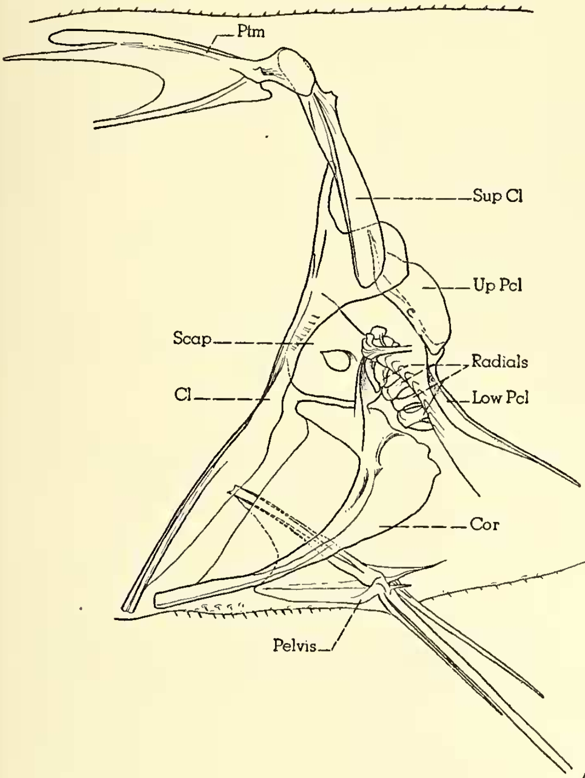
The cleithrum shows less of the antero-posterior wing-like extension than it will later on, and the superior finger is relatively longer. From the base of this extension the cleithrum extends down and forward for more than three-fourths of its entire length as a long, thin rod, reaching the body contour, behind the posterior ends of several branchiostegals, and well ossified throughout. But there is no hint of the overlying extension which later will curve partly over the scapular and only an imperfect hint of the future thin sheet of bone which will completely close the cleithrum-coracoid interspace.

Underlying both the ventral tip of the supracleithrum and the posterior wing of the cleithrum is the upper postcleithrum. This consists of an anterior thickened, rodlike margin flaring out behind into a broad, oval sheet of bony tissue. It extends down and back to beneath the first pectoral spine. Closely articulated with the lower end of this marginal rod is the lower postcleithrum. This is half again as long as the upper element, and describes a long, sweeping curve behind and below the pectoral rays, slightly flattened anteriorly along its basal half, but thinning out into an elongate spine at the distal end.

The scapular is shaped much as in the adult bone, but the coracoid preserves its primitive, elongate, curved, rodlike character, except for a posterior wing flaring out from the proximal half, and an anterior tongue of thin bone paralleling the ventral aspect of the scapular. The lower, forward extension of the coracoid falls short of the corresponding end of the cleithrum. The actinosts are difficult to discern clearly but there are certainly five, all ossified, the uppermost oblique one extending back from the base of the stout, pectoral spine, and intimately connected with the posterior border of the scapular.

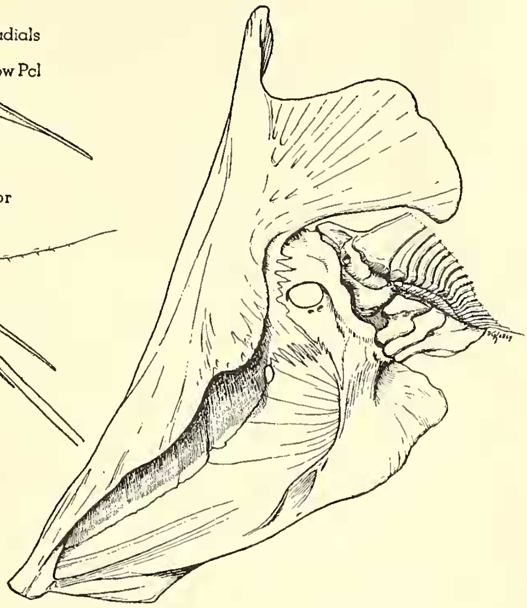
Pelvic Girdle: This well-ossified and muscled girdle indicates an active usefulness of the external fins to which we have as yet no exact knowledge or clue. Each fin consists superficially of a spine and two rays, one of the latter being very greatly elongated. These all arise from a relatively small, bony, subdermal base from which in turn spring several diverse elements. Anteriorly, from the spine side, a thin bony fan extends for a short distance forward and down. Superiorly and obliquely forward, two long slender spines reach up between the coracoids, and on across the almost empty intervening space, nearly to the mid-portion of the cleithrum.

Posteriorly a shorter, stouter spine or style is



Text-figure 5.

Pectoral and pelvic girdles of 84 mm. *Istiophorus greyi.* × 12.



Text-figure 6.

Pectoral girdle of adult *Istiophorus americanus.* Reduced 1¾.

directed backward, connected with the pelvic base by a wide, thin bony fan or wing. Below this, and arising from the base itself is a second, shorter spine. The external pelvic spine proper is closely applied to the first elongate ray, while the shorter ray, although attached by webbing to the long one, is freely movable, and has a separate origin, arising not from the bony complex, but from the base of the posterior style.

The base doubtless consists of several radials or actinosts, but nothing can be decided with certainty until both younger and older specimens are available.

Istiophorus americanus Cuvier & Valenciennes.

Atlantic Sailfish.

Material Studied: One young specimen, standard length 70 mm., from Florida. Cat. No. 28,932. KOH No. 2330. Presented by Duncan Holmes, August 12, 1938.

Note: This specimen was in bad condition, many of the spines and rays being partly lacking and the webs torn. The young fish has been cleared and stained. Its description will consist only of comparison with the 42 and 84 mm. specimens from the Pacific. Its standard length is 83% that of the latter.

Color: As this fish was in alcohol for some time before coming into my hands, all definite color, both of the body and fins, has disappeared. The dorsal fin shows considerable brown pigment but no pattern.

Food: In the stomach of this young sailfish there was a larval fish, bitten in half, about 15 mm. in length. The urostyle with four, large, separate hypurals indicates extreme youth, and the character of the vertebrae is distinctly clupeoid. In addition to this, seventeen copepods were present (Cat. No. 4,058). These were as follows: 1 *Oncaea* sp.; 1 *Oithona* (male) sp.; 15 *Farranula rostrata.* The latter had been swallowed whole, and were so undamaged that there was no doubt even about the species.

Dr. Charles B. Wilson, who kindly identified these for me, writes interestingly as follows: "I have gradually come to regard the copepods as holding the same relation to the fishes, that milk does to the mammals. No matter what the ultimate food of the adult may be, the newly born young subsist for a time upon the same food: milk for mammals and copepods for fish. This is the first baby of any of the large carnivorous fish whose stomach contents I have had the privilege of examining, and it is gratifying to find that they start by feeding in part at least upon some of the very smallest of the tropical surface copepods."

Measurements: Total length 74.3 mm.; standard length 70; depth at pectoral 5.7; head 37; eyeball 3.4; snout 29.3; snout to first dorsal 29.3; snout to pectorals 36.6; snout to pelvics 39; maxillary 32; lower jaw-tip to snout-tip 21; upper pterotic spine 1; lower preopercular spine 3; dorsal height, fifteenth spine 20; caudal lobes 5.7; middle caudal rays 2; pelvic spine 1.75; pelvic elongate ray 13.4; pelvic short ray 2 mm.

Counts: Dorsal count $5 + 36 + 7 + 8 = 56$; caudal count $12 + 7 + 8 + 12 = 39$; pectoral count $1 + 18 = 19$; pelvic count $1 + 3 = 4$.

General Body Form: At the vertical of the pectoral origin, which is the least distorted part of the body, the depth is 5.6 mm., giving a relation of about eleven times in the body length.

Skin: The distribution and the general character of the body scales is exactly like the Pacific species, but the scales themselves are decidedly less developed. They are smaller and the central clear area is larger, and the spines are unexpectedly low, thick and blunt. This character is much more than we should expect in a fish only 17% less in length than the other. The largest scale is .2 mm. in diameter.

Lateral Line: The lateral line scales separating the long series of openings are distinct from the scales proper in possessing irregular thickenings on the surface. These are usually in two ragged lines or patches of rugosities across the upper and lower parts of the scale. None of the adjacent scales, above or below, are thus marked.

Cephalic Ridge and Spines: The serrated cephalic ridge over the eye is less developed, as is also the upper spine, but the lower one is longer than in either the 42 or the 84 mm. individuals. The upper spine very definitely arises from the external ridge and posterior end of the pterotic, overlying the point of attachment of the lower branch of the posttemporal. The lower, preopercular spine is very strong but only slightly serrated. It measures 3 mm. in length.

Dorsal Fin: In spite of the damage incurred, we can see that this fin was continuous and contained 56 elements, as in the 84 mm. fish. The same four divisions are evident, the relative numbers being $5 + 36 + 7 + 8$. Numbers 1 and 2 are subdermal at this stage, and in an uncleared specimen would not be distinguishable. The first 5 are true spines, separated from the succeeding elements by an even greater distinction in relative length of the 5th and 6th elements. Basally, there is another local grouping, elements 4 to 8 inclusive, whose bases and origins are very close together. The 6th to 37th ray-like spines compose the large part of the fin. The succeeding 6 are marked off by being shorter and more delicate, and will be among those lost in the adult. The posterior 8 are typical rays, close together, possess strong and deep supporting, subdermal bases, and will form the ultimately isolated 2nd dorsal.

Anal Fin: This is too damaged, even as to the bases, to count accurately. Twenty-two elements can be made out and there were probably several more.

Caudal Fin: Although considerably damaged, the caudal count can be made out to be identical with that of the 84 mm. fish, except that the central upper and lower halves are 7 and 8 respectively instead of 8 and 7.

Pectoral Fin: The pectoral formula is I-18. This fin is relatively smaller than in either of the Pacific baby sailfishes; 6.6% to the standard length, as compared with 10% and 7.6%. The rays articulate (distantly, at this stage) with four free radials; the two central ones more slender and flaring slightly at top and bottom; the outermost with an expanse of thin, external wing, and articulating closely at one side, with the outer shoulder of the coracoid. The innermost of the four contacts the postero-inferior angle of a 5th radial. The base of the pectoral spine is enlarged, and is intimately facetted with the upper end of this long, angular 5th radial, which is partly ossified with the posterior border of the scapular.

Pelvic Fin: The elongate pelvic rays are split 4.8 mm. from the tips, more than a third of their length, the split being normal, a character not apparent in either of the young Pacific fish. Almost at the point of division, the free tip of what appears to be a 3rd ray is visible, becoming at once merged with the larger stem.

Skull: The bones are slightly more distinct than in the larger fish, about as much as we should expect. The relation of the frontal, nasal, maxillary and premaxillary is as already described, as Gregory has deduced from the adult, and excellently illustrated.

Opercles: These bones are more strongly ossified than in the larger fish, and the opercle is distinct as far back as the base of the pectoral.

Teeth: There is no edentulous area in the upper jaw.

Caudal Complex: The general condition as compared with that in the 84 mm. fish shows slightly more separation of the various elements. One radical difference is the division of the upper half of the caudal fan bone, into two hypurals by a strong, transverse seam, which however, is not open. It extends clear across the bone, about one-fourth of the way up from the midline division. The separation between the two halves of the central hypurals is complete, extending clear down to the urostyle. Several vertebral divisions are faintly distinguishable near the base of the urostyle finger itself.

Dorsal Fin Bases: These are relatively much less ossified than they are in the 84 mm. specimen. At this stage, there can be very little muscle attachment for control of the great expanse of spines and webbing.

Pectoral Girdle: This is the most strongly ossified of all the fin bases. Even this young fish must have some important use for this elongate, narrow fin, although, as we have seen, the long rays are split into two branches for a full third of their length.

Istiophorus greyi Jordan & Hill.

Material Studied: Full grown male, of 2,616 mm. standard length, 2,946 mm. total length (nine feet, eight inches) over all; taken trolling with feather jig, 5:30 P. M. February 8, 1938, on the Eastern Pacific *Zaca* Expedition; Station 210, 9° 12′ North Lat., 85° 5′ West Long., twenty miles south of Cape Blanco, Costa Rica. Cat. No. 28,308; photographs 9081 and 9082; weight 115 pounds.

Color: Typical Pacific sailfish coloration, deep blue on upper half of body and along base of dorsal; with about twenty vertical pale bands down sides, some broken into a series of large whitish spots. Sail perfect, very large, deeply incised in the anterior portion; covered with small, blue spots.

Size and Weight: The following six Pacific fish give an average relation of length and weight for adult fish. The lengths are total:

2,730 mm.	78 pounds
2,743 mm.	92 pounds
2,781 mm.	100 pounds
2,794 mm.	94 pounds
2,946 mm.	115 pounds
2,965 mm.	117 pounds
3,073 mm.	130 pounds

Food: Seven small squids, 50 to 100 mm. long; one large squid with very large caudal fin, body 300 mm., with the caudal fin 120 mm. wide. Also a two-inch paper nautilus, shell and inmate (No. 38,211), and a 40 mm. *Chaetodon humeralis*, both quite uninjured.

A one-hundred-pound sailfish taken in the Pearl Islands, Panama Bay, had eaten five, eight-inch *Caranx caninus*.

Parasites: Only a single free copepod on the whole body of the sailfish, but clusters of slender parasitic copepods with brush-like gills at the distal end (Photograph 9083). Two of these clusters has several bright colored barnacles growing tightly to each stem. Those which carried no barnacles, trailed tremendously long and very thin threads of eggs. They are probably *Penella filosa* (Linnaeus).

Measurements: Total length 2,946 mm.; standard length 2,616; depth at pectoral 304; depth at first dorsal 331; depth at second dorsal 183; depth at peduncle 63; head 889; eyeball 53; iris, horizontal 41; iris, vertical 35; snout 599; snout to first dorsal 801; snout to pectorals 915; snout to pelvics 965; maxillary 686; lower jaw 279; lower jaw-tip to snout-tip 292; nostril to eye 25; anus in front of first anal 150; interdorsal width 77; first dorsal base 1,397; first dorsal height, first spine 496; first dorsal height, 15th spine, 1,003; dorsal sheath depth 51; first anal base 51; first anal height 234; second anal base 88; second anal height 77; caudal lobes spread 934; upper caudal lobe 546; lower caudal lobe 537; pectoral length 419; pectoral base 100; pelvic length 667 mm.

Counts: first dorsal count 3 + 36 + (*6*) = 39; second dorsal 7; first anal 2 + 11 = 13; second anal 6.

Skin: Much of the skin of the adult sailfish is covered with a multitude of minute mucous openings, sometimes in parallel lines. Many of these are surrounded by a well ossified, but tissue-thin plate or scale, oval or rounded, and easily detached. If the central portion lies over a mucous opening it is perforated, doughnut-like. Often the scale is a hemicircle or a small irregular piece, but when perfect it is rounded and perforated. On other large areas of the skin, these protective scales are found in all shapes, sizes and frequencies, or again for several inches, they may be in regular lines.

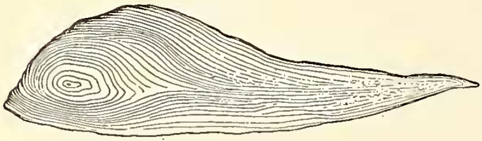
Under high power, a typical, elongate oval, guard scale is seen to have the surface covered with a mass of low, blunt tubercles, presenting a rough, crystalline appearance. The center is perforated with a large, oblong hole, and around this are grouped eleven enlarged, thick, sharp spines or teeth. Eight along the upper edge grow horizontally out and over the rim of the opening, completely protecting that side. On the opposite side are three slightly larger spines, more nearly vertical, also pointing over the edge but obliquely upward. This scale measured .45 long by .23 mm. wide. These toothed scales seem to be placed more regularly and to protect openings larger and of different origin from the multitudinous small mucous vents. (Text-fig. 7.)

The second type of adult scale is a stiff scute, strongly ossified, irregularly abundant, sometimes completely buried in the epidermis, more

Text-figure 7.

Mucous canal guard of 2,616 mm. *Istiophorus greyi*. × 15.

often half exposed. These all lie with their long axes longitudinal to the fish. They vary considerably in shape, but the commonest type is rounded at one end (the anterior or concealed end) and tapering slowly to a blunt point at the other end. These scales vary from 9 to 15 mm. and may occur in several depths of epidermal and dermal strata. The surface is covered with a succession of fine lines like those on an ordinary fish scale. These all focus on the center of the round end, giving an exact imitation of a thumb print. In a scale 3 by 10 mm. there were forty-three concentric lines between the center and the periphery of the round end. The lines are distinct as such, but they are also minutely beaded with rugosities. In one unidentified area of skin, these scutes were in the form of long, narrow splinters, 25 or more mm. in length, and lying close together well below the surface, forming an almost solid armor. (Text-fig. 8, and Plate III, fig. 6.)



Text-figure 8.

Dermal scute of 2,616 mm. *Istiophorus greyi.* × 6.5.

Teeth: The denticles on the jaws of the adult sailfish are short, stout, translucent white, sharp-pointed and slightly curved. They are very small, varying from .3 to .7 of a mm. Their arrangement is wholly irregular, their average distance apart being about their own height. In an area 4 by 4 mm. square, there were 42 denticles. They are very strongly inserted, and where they are lost, there remains a deep, round hole. (Plate IV, fig. 7.)

On the mandible and on the maxillary as far as the tip of the lower jaw, the denticles are confined to two broad bands about 12 mm. wide. The mandibular band is strongly transversely curved but horizontal, while that of the upper jaw is very flat and oblique, sloping up and outward. In each case the denticular band is raised above the surface of the adjacent surface of the jaw. Beyond the tip of the mandible, the maxillary band widens at once, and encroaches upon the ventral and dorsal surfaces until, in the distal third, the surface of the bone is completely covered. As the upper jaw becomes more and more flattened, dorso-ventrally, the strongest denticles come to be concentrated along the lateral edges, those above and below being smaller, more stub-like.

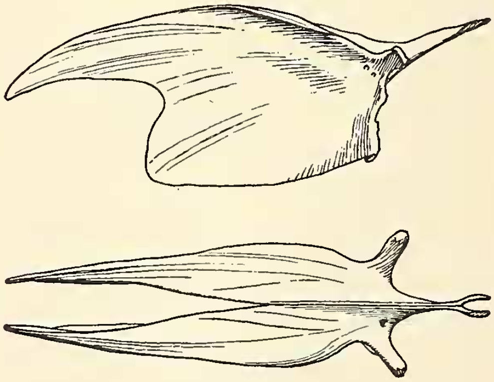
Pectoral Spine: This is a true spine, but when dry, it splits into longitudinal halves near the tip. This splitting bears no resemblance to the lateral dividing, natural to the other pectoral elements, which are true rays.

Anal Fin: Unlike some other Pacific specimens which I have examined, this individual had the first and the last rays of the second dorsal and second anal very considerably elongated.

Pelvic Fin: In the pelvic fin of the full-grown sailfish, the spine is usually very distinct, although closely applied to the base of the elongate ray. The spine is relatively smaller compared with this ray; 1 to 26 in the adult and 1 to 9 in the 84 mm. fish. At the base the spines are solidly ossified with a large, irregular transverse bone. From a hollow in this bone, arise two large rays. In one fin I examined these amalgamated and fused with one another more and more throughout the length of what appears usually to be a single, greatly elongated ray. In another specimen two additional, short, free rays were present, concealed between the bases of the fins. I have not had a chance to dissect out the last free ray (usually recognized as the 2nd).

In certain individuals the full complement of one spine and four rays seems to be present. Yet the elongate single or double ray has a deep, long dermal sheath provided for it and a very considerable expanse of webbing throughout its entire length. (Plate IV, fig. 8.)

Pelvic Arch: The adult pelvis is compact and complex, a single large bone with expanded, wing-like anterior portion, and a smaller, superior flange, flaring out inwardly and horizontally, just below the curved upper surface of the main bone. Posteriorly there arises a prominent, slender style. The pronounced superior curve and the great expanse of wing make it unlike the pelvis of any other family of scombroids. This whole affair is duplicated, and the two are joined together by the enlarged area of the horizontal flange, together with the base of the style. The fin itself is attached to a transverse, thickened area which articulates with the transverse base of the pelvic spine. The full length of the pelvic arch as compared with the elongated ray is as 1 to 6, whereas in the young fish it is 1 to 10. (Text-fig. 9.)



Text-figure 9.

Pelvic girdle of adult *Istiophorus americanus.* Reduced 1⅓.

Summary and Conclusions.

General: A most significant feature, evident at first glance at the three young sailfish, of 42, 70 and 84 mm. standard lengths, is that in spite of their diminutive size, they are, externally, absurdly like the full-grown adult fish. The greatly elongated upper jaw and pelvic fins, the enormous expanse of dorsal fin, are as characteristic of the 42 mm. specimen as they are of the adult fish more than sixty times as long.

When, however, we add to these externals of the normal opaque fish, the skeleton and other internal characters, we realize that there is little or no hint of the radical changes to come. The absence of intermediate material, such as two- or three-foot sailfish, only emphasizes that these young fish are isolated, well-balanced, efficiently functioning organisms in their own right. Like most typical fish they are covered with scales, their jaws are filled with teeth of ordinary pattern, and their two specialized fins impose no unusual activities or habits.

There is no hint of the subsequent complete disappearance of the armor of scales, and their replacement with minute mucous canal guards and bony scutes. Without having ever seen the full-grown fish we would never know that the teeth would all fall out, with the substitution of uncounted, cruelly sharp and strong denticles, covering the entire sword.

With this radical change in the dental armature of the snout, and the consequent shift from a prehensile snapping, to a slashing method of attack and feeding, the entire head and body will undergo vital changes. A mobile, twisting body will alter to a stiffened, recoil-guarded handle to the great sword; the parethmoid and other regions of the skull, the vertebrae and caudal complex, the fin bases, the pectoral arch—all will witness an ontogenetic swift and thorough thickening and extension of ossification. All joints will be stiffened, until the whole becomes a taut, tense spring, an organic engine to generate and direct the terrific ramming, hitting and slashing power of the solidly denticled sword.

In the young fish all this excess of bone formation is held in abeyance, adumbrated only, so that the toothed, scaled, prehensile stage of development may function as perfectly as though it would persist throughout the entire lifetime of the fish.

Scale Comparison of Young Xiphias *with* Istiophorus: The scales of a young *Xiphias gladius* of 87 mm. standard length (loaned by the American Museum of Natural History) are wholly unlike those of *Istiophorus* of corresponding size (84 mm.). In *Xiphias* all are of one general pattern, with broad, flat, irregular base, the periphery deeply incised, stellate, with many sharp points. Those covering the body as a whole, are small, with commonly two (rarely one or three) slender, sharp, straight spines. These scales form narrowly spaced longitudinal rows along the sides. The second type of scale is arranged in eight rows, four on each side of the body, all rather near the unpaired fins; those nearest being decidedly the largest. Each scale slopes up to a narrow central ridge, along which are usually four (rarely three or five) compressed, thick, backward curved, talon-like spines. The most unexpected thing about these is that they are fully webbed to the tips, like diminutive, unpaired fin spines.

In a smaller *Xiphias* of 40 mm. (No. 28,933) there is much less differentiation between the two types of scales, the whole body being densely clothed with the smaller ones. The character of these scales is as unlike those in young *Istiophorus* as those of the larger *Xiphias*.

Comparative Measurements: The accompanying table gives the relative percentages of measurements in four sailfish, with standard lengths of 42, 70, 84 and 2,616 mm. Although in outward general appearance even the smallest and the largest are extremely alike, yet the smallest is only 1.6 percent of the standard length of the largest, while its weight is 194,190 times less than that of the adult.

The depths of the four fish show little change, the extremes at the vertical of the origin of the dorsal being 10 and 12.7% (always considering the smallest fish first), and those at the peduncle being even closer.

The head is considerably larger in the three young, more than half the length of the fish, while it diminishes to a third in the adult. The eye, as so often the case, is larger in the immature fish, the relative decrease being one-half to two-thirds. The three measurements of snout to dorsal, pectorals and pelvics are relatively similar, all more than half the standard length in the young and decreasing to one-third in the old one. Both the maxillary and the lower jaw show similar but less extreme reductions. The cephalic spines show diminution even from the 42 to the 70 mm. ages, and of course are wholly lacking in the oldest individual. The greatest height of the dorsal presents little relative growth change, the two extremes being 32 and 38.4%.

There is radical change in the caudal fin. The length of the lobes shift from 10% in the smallest infant, to 20 in the adult, and the spread of the fin is still more marked, 7.8 to 35%. Greatest of all are the changes in comparative lengths of the middle and outer caudal rays, from 85% in the more normally shaped tail of the small fish to only 10.5% in the mighty crescent of the full-grown sailfish. The pectoral length increases from 10 to 16%. The pelvic spine, although short and consolidated in the young (2.5 to 3.5%), becomes of even less importance in the old fish, a mere seven-tenths of 1%. The length of the elongate pelvic ray shows considerable variation in the young fish themselves, from 10% in the 70 mm. Florida specimen, to 26% in the 42 mm. baby. In the adult sailfish this elongate ray has increased only to 30%.

	Percentages in Standard Length.			
Total length	46.5 mm.	74.3 mm.	91 mm.	2,946 mm.
Standard length	42 mm.	70 mm.	84 mm.	2,616 mm.
Depth at pectoral	10%	8%	7.6%	11.6%
Depth at dorsal	10		8	12.7
Depth at peduncle	3	2	2	2.4
Head	51.6	53	53	34
Eye-ball	6.6	4.8	4.7	2
Snout	35.7	42	41	23
Snout to dorsal	50	52	51.7	30.6
Snout to pectorals	52.4	55.7	54	35
Snout to pelvics	52.8	56	54.8	37
Maxillary	42.8	45.7	46	26
Lower jaw	19	18	16.7	10.7
Lower jaw to snout tip	22.6	30	30	11
Upper pterotic spine	4	1.4	1.6	——
Lower preopercular spine	6.6	4.3	3	——
Dorsal height, 15th spine	32		33	38.4
1st anal lobe height	5		4	9
1st anal lobe base	3.5		2.8	8.6
2nd anal lobe height	2.4		2	3
2nd anal lobe base	2.4		2.8	3.4
Caudal fin spread	7.8		12.8	35.7
Upper caudal lobe	10	8	10	21
Lower caudal lobe	11		10	20.5
Mid. caudal rays	85		87	10.5
Pectoral length	10	6.6	7.6	16
Pelvic spine	3.5	2.5	2.6	.7
Pelvic 1st ray	26	10	23.8	30
Pelvic 2nd ray	5.5	3	3.8	

Antero-posterior Growth Increase: To illustrate the well-known antero-posterior extension of various parts of the skeleton of the sailfish, the vertebral comparison of young with adult must suffice. This shows the very marked shift in proportions during post-larval ontogenetic development. This table shows the relative proportions of times height in length, of eight vertebral centra in the 84 mm. fish and an adult.

Vertebrae	84 mm.	Adult.
5th vertebra	2	2.3
10th vertebra	2	3.6
13th vertebra	2	3.1
15th vertebra	1.8	4
18th vertebra	1.7	4.1
20th vertebra	1.4	4.6
22nd vertebra	1.8	3
23rd vertebra	1.8	2.5

Unpaired Fin Counts: The following comparative dorsal and anal fin counts of various growth stages are taken from illustrations, as well as from skins and mounted specimens, and from the freshly caught fish which I have studied. I present the data chiefly to show how weak and unreliable a character for systematic specific differentiation is the count of the elements of the unpaired fins.

Shape of Dorsal: A character which, in my material, is shown only by extremes, is the general profile of the dorsal. In the young fish of 42 and 84 mm., the great sail is almost a perfect hemicircle, highest in the center, where the 15th ray or thereabouts is the longest. In the adults, both Atlantic and Pacific, there is a deep notch in the anterior third of the distal profile. There is no hint of this in the young, not even an incipient weakness in the distal portions of the elements, such as is evident in that posterior section destined for obliteration in the full-grown sailfish.

Teeth: Correlated with what we have found to be true of the body scales, there seems no connection whatever between the normal piscine teeth of the young sailfish, arising in a dominant single row along the edge of the jaws from broad, flat, easily detachable bases, and the solid, irregularly distributed, tusk-like denticles of the full-grown fish.

No material is available for showing any transitional stages. Except for the sensible loss of some distal maxillary teeth in my 84 mm. specimen there is no evidence of any coming, radical change.

Food: The most striking thing about the food of the young sailfish is the similarity of diet in both Atlantic and Pacific individuals. In each there was a skeleton of a very young shore fish, in one case certainly, and in the other probably, a clupeoid. The remaining food was exclusively copepods, and copepods belonging to the very smallest of the tropical surface forms, all within the suborder Cyclopoida, characterized, at least in *Farranula* and *Corycaeus*, by very large, forwardly-directed eyes. Most of these copepods are extremely small species, less than a millimetre in length.

While the small fish food was bitten in two, the copepods had been swallowed whole, the solid rows of young sailfish teeth having wrought no damage whatever. The dominant copepod food of the Atlantic fish consisted of *Farranula rostrata*, while that of the Pacific individual was *Farranula gibbula*. These two young sailfish were taken in different oceans, separated by twelve

Dorsal Counts.

mm.			
5	Undifferentiated		Atlantic (Lutken, 1880)
9	"A low fringe."		Atlantic (Günther, 1873–4)
14	21	= 21	Atlantic (Günther, 1873–4)
42	5 + 35 + 6 + 9	= 55	Pacific (Beebe, page 210)
70	5 + 36 + 7 + 8	= 56	Atlantic (Beebe, page 219)
84	(1)4 + 37 + 6 + 8	= 56	Pacific (Beebe, page 213)
108	3 + 45 + 8	= 56	Atlantic (Cuvier, 1831)
457	2 + 45 + 7	= 54	Red Sea (Ruppell, 1841)
Adult	3 + 30 (7 subdermal)	7 = 47	Atlantic (Goode, 1883)
Adult	41 (Space)	7 = 48	Atlantic (Jord. & Ever., 1896)
Adult	40 (6 Stubs)	7 = 47	Atlantic (Amer. Mus. skin)
Adult	40 (6 Stubs)	7 = 47	Atlantic (Amer. Mus. skin)
Adult	34 (Space)	8 = 42	Pacific (Panama, Mounted)
Adult	33 (13 Stubs)	7 = 40	Pacific (Panama, mounted)
2616	3 + 36 (6 Stubs)	7 = 46	Pacific (Beebe, page 221)

Anal Counts

5	Undifferentiated		Atlantic (Lutken, 1880)
9	Undifferentiated		Atlantic (Günther, 1873–4)
14	13	= 13	Atlantic (Günther, 1873–4)
42	11 + 7 + 8	= 26	Pacific (Beebe, page 210)
84	9 + 8 + 8	= 25	Pacific (Beebe, page 213)
108	12 + 8 + 8	= 28	Atlantic (Cuvier, 1831)
457	10 (Space)	7 = 17	Red Sea (Ruppell, 1841)
Adult	11 (9 Stubs)	7 = 18	Atlantic (Goode, 1883)
Adult	9 (Space)	7 = 16	Atlantic (Jord. & Ever., 1896)
Adult	9 (Space)	8 = 17	Pacific (Panama, mounted)
Adult	9 (Space)	8 = 17	Pacific (Panama, mounted)
2616	2 + 11 (Space)	6 = 19	Pacific (Beebe, page 221)

hundred miles of longitude, and six hundred of latitude.

The adult fish is commonly reputed to obtain its food by using the snout like a slashing broadsword, yet the fish and squid food which I have examined, together with such delicate objects as the shell of a paper nautilus, were all swallowed whole and undamaged.

Diagnostic Characters: In the young fish two characters only stand out as even faintly diagnostic. In the 70 mm. Atlantic fish, the scale spines are short, thick and blunt, not long and slender as in the 42 and 84 mm. Pacific sailfish. The former has a slightly shorter pectoral fin, 6.6% of the standard length, not 7.6 and 10% as in the two latter young fish.

Characters of Growth Stages: For what they are worth, I present a summary of a few characters taken from a series of growth stages, from illustrations and from my specimens. It is possible that several of these may belong to different genera, but their very inconsistencies will be of value when a complete series of newly caught young fish is available. Text-figure 1, a–j. Page 210.

Length 5.5 mm. (Lütken, 1880).

Jaws equal.
Completely toothed.
Lower spine as long as jaws.
Dorsal, a long finfold.
Pectorals, large and rounded.
Pelvics, rudimentary.

Length 9 mm. (Günther, 1873–74).

Jaws equal.
Completely toothed.
Lower spine equals jaws.
Dorsal, a long, low fringe.
Pectorals, large and angular.
Pelvics, short buds.

Length 14 mm. (Günther, 1873–74).

Upper jaw slightly the longer.
Completely toothed.
Lower spine equals jaws.
Dorsal high, equal to snout.
Pectorals rounded.
Pelvics elongate filaments.

Length 16.5 mm. (LaMonte & Marcy, 1941).

Upper jaw slightly the longer.
Completely toothed.
Lower spine ⅔ of jaws.
Dorsal high, equal to jaws.
Pectorals angular.
Pelvics elongate filaments.

Length 42 mm. (page 210).

Upper jaw 2¼ long as lower.
Completely toothed.
Lower spine equals eye.
Dorsal very high, rounded.
Pectorals large, rounded.
Pelvics elongate, ¾ snout.

Length 60 mm. (Günther, 1873–74).

Upper jaw twice lower.
Lower spine 1½ eye.
Dorsal higher in front.
Pectorals long, rounded.
Pelvics moderate filaments, 2½ eye.

Length 84 mm. (page 213).

Upper jaw 2.7 times lower.
Tip of upper edentulous.
Lower spine 1½ in eye.
Dorsal high, rounded.
Pectorals moderate, angular.
Pelvics elongate, 1.4 in lower jaw.

Length 108 mm. (Cuvier, 1831).

Upper jaw 2½ lower.
Tip of upper edentulous.
Lower spine ½ eye.
Dorsal high, sloping back.
Pectorals long, slightly falcate.
Pelvics longer than lower jaw.

Length 457 mm. (Ruppell, 1841).

Upper jaw 1½ lower.
Completely toothed.
No spine.
Dorsal very high, rounded.
Pectorals small, angular.
Pelvics equal dorsal height.

Length 2616 mm. (page 221).

Upper jaw 2½ times lower.
No teeth, replaced by denticles.
Dorsal with deep anterior notch.
Pectorals falcate, long.
Pelvics nearly equal upper jaw.

Istiophorus americanus

As this article was going into final page proof, Miss Lyle McCaleb sent me a beautiful photograph of a young sailfish taken by Aubrey Nelson at Aransas Pass, Texas, August 31, 1941, said to weigh less than a pound, and to measure 20 inches in total length. The fish has been mounted, so is not available for study, but many details are distinct in the photograph (Plate V, Fig. 9).

It compares very closely with the illustration of Ruppell's specimen of 457 mm. (*Trans. Zool. Soc. London*, II, 1841, p. 71, Plate 15). Together with that fish it exhibits an adult contour of the caudal fin, wholly unlike the tail of all smaller individuals.

From the excellent photograph I have been able to make out the following percentages, all of the standard length of 437 mm. Depth 9.5%; head 38.6; eye 2.74; snout 32; maxillary 34.8; lower jaw 14.4; upper jaw overhang 21.6; pectoral length 7.2; dorsal height 29.7%. The pelvics are partly buried in their sheath, so cannot be correctly estimated.

These measurements resolve as follows, as compared with sailfish of 42 mm., 84 mm. and 2,616 mm. standard lengths: the head is much nearer that of the adult, as is the size of the eye; the snout is like the smallest, but the lower jaw is median in proportion; the jaw overhang is close to that in the 42 mm. fish, but the pectoral length corresponds to the fin of the 84 mm. sailfish.

The exact shape of the dorsal fin is uncertain, but it appears to show little of the adult, anterior, profile depression. Forty elements are distinguishable back to the short posterior rays, and the interval between the future first and second dorsals is occupied by short, webbed stubs. Teeth are faintly visible in both jaws, at least as far as the tip of the lower; spines are absent, and the pectorals seem quite falcate.

For comparison with the ten growth stages I have shown in Text-figure 1, I offer the following caption:

437 mm. (Texas, 1941).

Upper jaw 2.4 times lower.
Jaws proper toothed, snout uncertain.
No spines.
Dorsal high and rounded.
Pectorals falcate.
Pelvics equal one-half head.

Selected Bibliography

Beebe, W.
1938. Eastern Pacific Expeditions of the New York Zoological Society. XIV. Introdustion, List of Stations, Nets and Dredges of the Eastern Pacific *Zaca* Expedition, 1937–1938. *Zoologica*, 23, pp. 287–298.

Cuvier, G. & Valenciennes, A.
1831. Histoire Naturelle des Poissons, 8, pp. 222 and 223. fig. 230.

Goode, G. B.
1883. Materials for a History of the Sword Fishes. *Report U. S. Fish Comm.* 1880 (1883), 8, p. 87, Pl. XII.

Günther, A.
1873–74. Erster ichthyologischer Beitrag nach Exemplaren aus dem Museum Godeffroy. *Jour. Mus. Godeffroy*, Hamburg, Band 1, Heft 2, pp. 169–173.

Jordan, D. S. & Evermann, B. W.
1896. The Fishes of North and Middle America. *Bull. U. S. Nat. Mus.* 47, pt. 1, p. 98.

Jordan, D. S. & Hill, H. R.
1926. In Jordan and Evermann, *Occ. Paper No. 12, Proc. Cal. Acad. Sci.* p. 41, pl. 14.

LaMonte, F. & Marcy, D. E.
1941. Swordfish, Sailfish, Marlin and Spearfish. *Ichth. Cont. Inter. Game Fish Ass.* I. No. 2, pp. 13–16.

Lütken, C.
1880. *Kongelige Danske Vidensk. Selsk. Skr. 5 Raekke, naturvidensk. og mat.* Afd. XII, 6, pp. 441–447.

Ruppell, M. E.
1841. Memoire sur une novelle Espèce de Poisson de Genre Histiophore, *Trans. Zool. Soc. London*, II, p. 71, Pl. 15.

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. *Istiophorus greyi*, 42 mm., photographed at moment of death. × 2.7.

Fig. 2. *Istiophorus greyi*, 42 mm., from a drawing from life by George Swanson. × 2.

Plate II.

Fig. 3. *Istiophorus greyi*, 84 mm., photographed at moment of death. × 1.2.

Fig. 4. *Istiophorus greyi*, 84 mm., from a drawing from life by George Swanson. × 1.5.

Plate III.

Fig. 5. Scales of 84 mm. *Istiophorus greyi*. × 18.

Fig. 6. Dermal scute of 2,616 mm. *Istiophorus greyi*. × 10.

Plate IV.

Fig. 7. Rostral denticles of 2,616 mm. *Istiophorus greyi*. × 12.

Fig. 8. Pelvic fins of 2,616 mm. *Istiophorus greyi*. (Reduced 5).

Plate V.

Fig. 9. *Istiophorus americanus*, 20 inches total length, 437 mm. standard length, taken 3 miles off Aransas Pass, Texas, August 31, 1941, by Aubrey Nelson. (Reduced 3.5).